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TESTIMONY OF DR. DONALD LYNAM
ETHYL CORPORATION
IN SUPPORT OF THE
HiTEC® 3000 WAIVER APPLICATION

I. INTRODUCTION

Good morning. I am Donald R. Lynam, the Director of Air Conservation and Industrial Hygiene for Ethyl Corporation ("Ethyl"). I am here to speak briefly in support of Ethyl's waiver application for the HiTEC® 3000 Performance Additive ("the Additive"). With me today on the panel are F. William Brownell of Hunton & Williams, Ethyl's counsel and Ralph Roberson of SAI, a consultant to Ethyl. Also present to assist me in answering questions regarding the waiver application are several of Ethyl's technical staff members and independent consultants who have undertaken testing and evaluation of the Additive.

By way of background, the Additive for which Ethyl seeks a waiver under § 211(f)(4) of the Clean Air Act is a manganese-based octane improver. The addition of one drop of the Additive in a gallon of gasoline improves the octane of the gasoline by about one octane number at approximately one-third the cost of currently available alternatives for enhancing octane. Use of the Additive would enable an enormous annual savings in crude oil, and an annual net reduction of pollutants of up to 1.7 billion pounds by 1999.

As you are no doubt aware, Ethyl's waiver application contains an immense amount of information about the Additive -- enough to fill more than eight large three-ring binders. It provides the results of the most extensive series of vehicle

emission and other tests ever undertaken by a private company in support of a waiver application. Among other things, it describes the results of a core test program designed in consultation with the three major U.S. automobile manufacturers and staff of the U.S. Environmental Protection Agency ("EPA" or "Agency"). This test program generated thousands of emission measurements from 48 cars operated for a total of more than three million miles, half of the cars using a test fuel containing the Additive, and half using the same test fuel without the Additive. All Ethyl tests were carried out by two independent laboratories.

Second, the waiver application describes the results of testing to determine what impact, if any, use of the Additive has on materials used in automotive fuel and emission control systems, including catalytic converters.

Third, it provides an analysis of emissions associated with use of the Additive to determine whether use of the Additive would affect public health.

II. THE RESULTS OF THE 48-CAR TEST PROGRAM AND ANALYSIS

Focusing on the major findings of this testing, use of the Additive over the course of 75,000 miles of vehicle operation reduced nitrogen oxide, on average, by 20 percent (0.11 gram per mile). Carbon monoxide emissions were reduced, on average, by seven percent (0.22 gram per mile). While hydrocarbon emissions increased slightly for the vehicles using the Additive, this small effect was not significant because it did not cause or contribute to the failure of the test vehicles to meet the

hydrocarbon emission standard. Overall, total regulated emissions from vehicles operating on fuel containing the Additive were lower, on average, than clear fuel vehicles by about eight percent (0.30 gram per mile).

Notwithstanding these impressive test results, some automobile companies maintain that additional testing must be completed before EPA can approve the waiver application. These companies seem to have two basic concerns. First, they suggest that in light of the more stringent emission standards established by the Clean Air Act Amendments of 1990, any increase in hydrocarbon emissions -- no matter how small -- is unacceptable. Second, they suggest that use of the Additive will adversely affect the operation of catalytic converters. Neither claim withstands scrutiny.

With respect to the first issue, testing completed by Ethyl establishes that use of the Additive will not cause or contribute to the failure of emission control devices or systems to meet existing emission standards. Testing and analysis also demonstrated that technology adequate to meet the more stringent emission standards already exists in a wide array of vehicle types, and that use of the Additive in vehicles equipped with such technology will not cause or contribute to the failure of vehicles to meet these more stringent standards. Indeed all of the vehicles in Ethyl's test fleet which remained below the existing hydrocarbon standard over the course of 75,000 miles of vehicle operation would also have met the more stringent

hydrocarbon emission standard. This result applies even though these vehicles were not designed to meet the more stringent hydrocarbon emission standard. Given the availability of this proven technology, the claim that any increase in hydrocarbon emissions, however small, will jeopardize compliance with the future hydrocarbon emission standard is without merit.

As for the catalytic converters, the data do not support the assertion that use of the Additive will adversely affect their operation. While use of the Additive results in some deposition of manganese oxide on catalytic converters, testing conducted by Ethyl has repeatedly shown that this deposition does not affect the operation of the converter. In-use conversion efficiencies for test vehicles fueled with the Additive are either the same as, or better than, those for clear fuel vehicles, while catalytic converter back pressures remain unchanged.

In response to suggestions from the auto industry, Ethyl initiated additional testing of the catalytic converters used in the 48-car test fleet. Results from these tests, which included testing of catalytic converters on a common "slave" engine and extreme, high temperature and speed testing of the Additive in a pair of Chevrolet Corvettes equipped with close coupled catalysts, confirm that use of the Additive does not plug or otherwise adversely affect catalytic converter operation.

III. RESPONSES TO QUESTIONS RAISED BY THE AGENCY

I will turn now to three specific issues raised by the Agency in the fall of 1990, and will summarize the results of

various test programs Ethyl undertook to respond to these issues. These issues were first, whether the independent laboratories retained by Ethyl to conduct emission testing as part of the 48 car test fleet program produced emission measurements which correlate with EPA's emission measurements. Second was whether manganese emissions associated with use of the Additive would adversely affect public health. The third issue was whether use of the Additive would substantially increase particulate emissions, as EPA had apparently observed in limited ad hoc testing in August-October 1990.

A. The Results of a Joint EPA/Ethyl Correlation Test Program Confirm that the Independent Laboratories Retained by Ethyl to Measure Emissions from the 48-Car Test Fleet Are Valid.

As noted, one issue raised by EPA was whether the hydrocarbon emission measurements obtained by the independent laboratories conducting the 48-car test fleet program correlate with hydrocarbon emission measurements obtained by EPA's Ann Arbor test laboratory. To address this issue, Ethyl and EPA designed and initiated a joint EPA/Ethyl correlation test program to measure emissions from a common set of test vehicles.

The results of this joint EPA/Ethyl correlation test program show that measurements of hydrocarbon emissions at the EPA and independent laboratories were equivalent. This result further establishes the validity of the thousands of emission measurements obtained by the independent laboratories as a part of Ethyl's 48-car fleet test program. As I have already noted, the emission data from the 48-car test fleet program clearly show

that use of the Additive will not cause or contribute to the failure of emission control devices or systems to meet applicable emission standards.

B. Manganese Emissions Associated with Use of the Additive Will Not Adversely Affect Public Health.

A second issue raised by EPA was whether the inhalation of manganese emissions associated with use of the Additive would adversely affect public health. They will not. Since November 1990, several independent studies have established that even maximum manganese exposure levels associated with use of the Additive will remain well below the very conservative level deemed by EPA's Office of Research and Development ("ORD") to be protective of public health. This level, known as the inhalation reference concentration (or "RfC") for manganese, is 0.4 ug/m^3, and represents the atmospheric concentration of manganese to which individuals, including sensitive subpopulations, could be exposed over a lifetime without appreciable risk of adverse health effects.

Based upon conservative exposure models, two of these independent studies indicate that average ambient levels of manganese in urban areas around the nation, assuming widespread use of the Additive, would be about 0.05 ug/m^3, a level about one-tenth the manganese RfC. Manganese exposures for the most highly exposed population segment would also be well below ORD's RfC for manganese, totaling, at most, no more than 0.2 ug/m^3.

I should note that these modeled estimates are based on as much as 30 percent of the manganese in the fuel being emitted from the tailpipe. Use of this 30 percent figure is conservative because it is based on the results of a manganese balance analysis conducted by Southwest Research Institute in San Antonio, Texas using a driving cycle designed to maximize manganese tailpipe emissions. By contrast, all available manganese emission data obtained for normal urban driving conditions, including measurements obtained by EPA, establish that no more than about 10-15 percent of the manganese in the fuel would be emitted in urban areas. The modeled estimates I have described therefore reflect the use of worst case assumptions.

In yet a third independent exposure assessment, Ethyl undertook a personal exposure monitoring program in Toronto, Ontario where use of the Additive is permitted in gasoline at up to twice the concentration sought in this application. The results of this monitoring program show that the modeling results I just reported were indeed conservative. These results show that use of the Additive -- even after more than ten years of general use -- does not increase exposure to manganese much above background levels, and that the exposure levels of individuals, such as cabdrivers, exposed to high levels of automotive emissions are only about one-tenth the manganese RfC. (Mean air levels for offic eworkers was 0.013 microgram per cubic meter and for cab drivers 0.035 microgram per cubic meter.)

Finally, you have heard me characterize the manganese RfC of 0.4 ug/m³ as very conservative. In deriving the manganese RfC, ORD assumed that manganese exposures had increased over time for workers at the industrial plant examined in the health study on which the RfC is based. The authors of that study, as well as managers of the relevant industrial facility, however, have reported that manganese exposures at the plant have, if anything, remained constant over time.

This means that ORD's manganese RfC should more accurately be about three times higher, or about 1.2 ug/m³. This level is more consistent with those deemed to be protective of public health by other independent health organizations such as the U.S. Public Health Service's Agency for Toxic Substances and Disease Registry which has recommended a level of 2 ug/m³, and the World Health Organization's Air Quality Guideline of 1 ug/m³. Exposures to manganese associated with use of the Additive fall even further below these more accurate levels for protection.

We conclude from these exposure analyses that there is no basis upon which to conclude that manganese emissions associated with use of the Additive would increase exposure significantly or consequently affect public health.

C. Use of the Additive Will Not Substantially Increase Emissions of Particulate Matter.

Finally, based on the results of limited, ad hoc testing conducted in August to October 1990 and March to May 1991, EPA questioned whether use of the Additive might substantially increase total particulate matter emissions. Additional testing

and analysis completed by Ethyl since November 1990 make clear that the Additive will not materially increase total particulate matter emissions.

First, testing completed by Ethyl, and recently confirmed by EPA, establishes that the fuel containing the Additive used by EPA as part of its ad hoc test program was contaminated with Freon® 12, a common chloroflurocarbon refrigerant.

Further testing by Ethyl, and more recently by EPA, also confirms that the presence of Freon® 12 in gasoline increases the emission of total particulate and hydrocarbons. Thus, the gaseous and total particulate emission data from EPA's ad hoc test programs are now irrelevant to a decision on Ethyl's waiver application.

Second, as part of the joint EPA/Ethyl correlation test program, the independent laboratories and the EPA Ann Arbor lab measured emissions of particulate matter using a common, uncontaminated test fuel and a common set of test vehicles. As with the gaseous emission correlation program, particulate emission measurements for the EPA and independent laboratories were equivalent using the uncontaminated fuels. These particulate measurements were also fully consistent with the results of an extensive particulate matter emission test program conducted by Southwest Research Institute ("SWRI").

The SWRI test program showed that use of the Additive had no significant effect on particulate emissions. Use of the Additive increased particulate emissions by about 0.003 gram per mile, on

average, increasing baseline particulate emissions from about 0.008 to 0.011 gram per mile. This is an insignificant effect considering that there currently is no particulate emission standard applicable to gasoline powered light duty motor vehicles, and that the standard applicable beginning in 1994 is almost ten times higher, or 0.08 gram per mile.

IV. RESPONSE TO FORD'S RECENT ENGINE DURABILITY AND FUEL EFFECTS TESTS

Turning now to a brief discussion of the Motor Vehicle Manufacturers Association ("MVMA") testimony, I want to reemphasize that Ethyl's tests of the Additive -- several designed in consultation with EPA and the principal one with the auto companies -- have been extraordinarily diverse and comprehensive, by any reasonable measure. Ethyl's tests have been far more extensive than any so far conducted by private, commercial or governmental interests, including those just completed by Ford. Ethyl's tests have included: [Show Slide No. 1]

- Emission testing over 75,000 miles on each of 48 cars (8 models).
- Catalyst durability testing extended over 100,000 miles on General Motor Corsicas, 25,000 miles (at 100 miles per hour constant speed) on General Motor Corvettes, and 35,000 miles at up to 80 miles per hour on Ford Crown Victorias.
- Joint Ethyl-EPA emission correlation tests on a variety of test vehicles.
- Fuel specific tests, some involving EPA, which demonstrated no adverse differences between commercial and certification fuels blended with the Additive.

- Tests with MTBE and ethanol showing both compatibility and an additional likelihood of benefits from use of the Additive.

The results of these extensive tests uniformly show that use of the Additive will not cause or contribute to the failure of emission control devices to meet applicable emission standards.

The Ford test program described by the MVMA panel, by contrast, was very limited, and used a durability driving cycle strikingly different from that used for vehicle certification. While Ethyl has had little time and only partial information upon which to comment on the recent eight-vehicle test conducted by Ford, a preliminary review suggests substantial uncertainties.

First, the data generated by Ford are very limited when compared to the data generated by Ethyl. In comparison to the thousands of emission data points obtained as part of Ethyl's 48-car test fleet program over the course of over three million miles of vehicle operation, Ford has reported only about 120 emission data points for eight vehicles.

Second, Ethyl used a more rigorous test protocol than did Ford, and was thus able to conduct the statistical analyses traditionally applied by EPA to determine whether an Additive causes or contributes to the failure of emission control devices to meet applicable emission standards. These traditional analyses and other more powerful statistical analyses uniformly show that the Additive meets the § 211(f)(4) standard for use of new fuel additives. Ford, by contrast, attempted only to discern

whether use of the Additive in a limited number of test vehicles had an adverse affect on emissions.

Third, Ford has generally limited its analysis of emission effects to a description of differences attributed to use of the Additive without supplying the underlying data from which these differences were calculated and independent comparisons made. Without full details of actual vehicle tailpipe emission measurements, neither the Agency nor Ethyl, is in a position to judge fully the merits of the Ford analysis.

Fourth, because of the small number of vehicles tested, the limited data provided by Ford are difficult to interpret. Results from Ethyl's 48-car test fleet program showed that emissions can vary substantially from one measurement point to another, even within as little as 5000 miles of vehicle operation. This variation can be seen in the emission results for the Ford Crown Victorias used in Ethyl's test program. **[Show Slide No. 2]**. This slide shows that at the 30,000 and 50,000 mile measuring points vehicle emissions trends changed substantially. Had Ethyl's emission testing been limited to those two mileage points, conclusions drawn would have been strikingly different.

It is axiomatic that as the numbers and varieties of data points and test vehicles decrease, the chances for anomalistic results and shaky statistics increase exponentially. Ethyl measured emissions of 48 cars every 5000 miles. Ford measured emissions of 8 cars at about 25,000 mile intervals. One example

of questions posed by thin data is the emission numbers for the four Ford Explorer test cars shown in Table II of Ford's 4 September 1991 submission (to the EPA docket) regarding particulates. **[Show Slide No. 3]** At 55,000 miles, one of the two clear fuel vehicles had average HC emissions of 0.154 gm/mile. The other twice that: 0.353 gm/mile. Similarly, a wide spread exists between the two MMT cars. Given these high car-to-car variations, it is speculative to infer that the differences seen are attributable to use of HiTEC® 3000.

Ethyl tested three clear and three Additive-fueled vehicles for each car model in its test fleet in order to eliminate or diminish the uncertainties caused by the vehicle to vehicle variability exhibited in the Ford test program. Six Ford Escorts were included in Ethyl's more rigorous test program. Results for these test vehicles contrast with the emission results reported by Ford for its four test vehicles. **[Show Slide No. 4]**

As the panel can see, emissions varied from vehicle to vehicle in the set of six Escorts in Ethyl's test fleet, but on average, the hydrocarbon emissions between clear and HiTEC® 3000 fuel were essentially nil. The slide superimposes and highlights the Ford data furnished to date.

Preparatory to the fleet test Ethyl tested four Chevrolet Corsicas, two on HiTEC® 3000 fuel, over 100,000 miles. **[Show Slide No. 5]** This slide shows the hydrocarbon emissions results. No emission standards were exceeded and hydrocarbon emission differences for the two sets of vehicles were inconsequential.

[Show Slide No. 6] A final slide by way of review displays the net, averaged differences in emissions between clear and HiTEC® 3000 fuels during Ethyl's 48 car, 8 model test fleet over 75,000 miles -- 25,000 miles beyond the designed operating limit of the emissions control systems. Emissions were measured every 5,000 miles. Anomalies, which were few, were thoroughly explored. Rigorous statistical procedures by outside consultants were applied in producing the data used in the slide.

Ethyl recognizes that an applicant for a waiver has the burden of providing data in support of the § 211(f)(4) standard. It stands to reason, however, that there is also a burden on those who contest an applicant's data -- namely, their critical analyses must stand up to equally close scrutiny. Ethyl does not believe, based on the available data, that the recent Ford test program -- as it pertained to the Additive -- was sufficiently controlled, objective and statistically sound to override or contradict the considerable data developed by independent laboratories on behalf of Ethyl.

The automobile companies have consistently opposed fuel additive waiver applications on the grounds that any non-hydrocarbon additives posed threats to the operation and longevity of automobiles. Such opposition, however, did not dissuade the Agency from approving waiver applications for gasohol, MTBE, or other oxygenates where in fact, the evidence in support of the applications was less extensive or convincing than that provided by Ethyl.

Ethyl shares the concern of the auto industry regarding the need to approve only fuel additives which meet the § 211(f)(4) standard. Ethyl has attempted in good faith -- and will so continue -- to work with the automobile companies. Meanwhile, Ethyl will critically examine data generated by the auto industry, just as the auto industry has critically reviewed Ethyl's test data. Ethyl will submit detailed comments on the Ford tests as soon as feasible following receipt of complete sets of data.

V. COMPATIBILITY WITH OXYGENATES

Before concluding, let me emphasize that the results of preliminary testing conducted by Ethyl show that use of the Additive can increase the emission reductions associated with oxygenated fuel additives. Emissions testing of oxygenated fuel additives has shown that such additives result in increases in nitrogen oxide emissions. The results of Ethyl's testing and analysis have shown that the benefits seen with the Howell EEE test fuel, including the nitrogen oxide emission reduction, continue to be found when the Additive is used in oxygenated fuels. Ethyl is continuing to conduct tests at the ALI Test Laboratory in Chicago, Illinois to develop further data on the potential synergistic benefits of using the Additive and oxygenates in combination in unleaded gasoline. The NO_x emissions reduction associated with use of HiTEC® 3000 has the potential for giving refiners substantial flexibility in meeting

the reformulated fuel and anti-dumping standards of the new Clean Air Act.

VI. CONCLUSION

In conclusion, Ethyl's efforts in support of this request for a fuel additive waiver have been unprecedented in terms of scope and detail, and have been subjected to a level of scrutiny by the Agency far beyond anything required for approval of any other fuel additive. The exhaustive testing and statistical analyses performed by Ethyl, and described in detail in the waiver application, not only demonstrate that the Additive meets the statutory standard for granting a fuel additive waiver, but show that use of the Additive will result in significant health, environmental and energy benefits.

Thank you for the opportunity to testify. My colleagues and I would be happy to answer any questions.

ETHYL TESTS

- Emission testing: 75,000 miles on each of 48 cars (8 models).

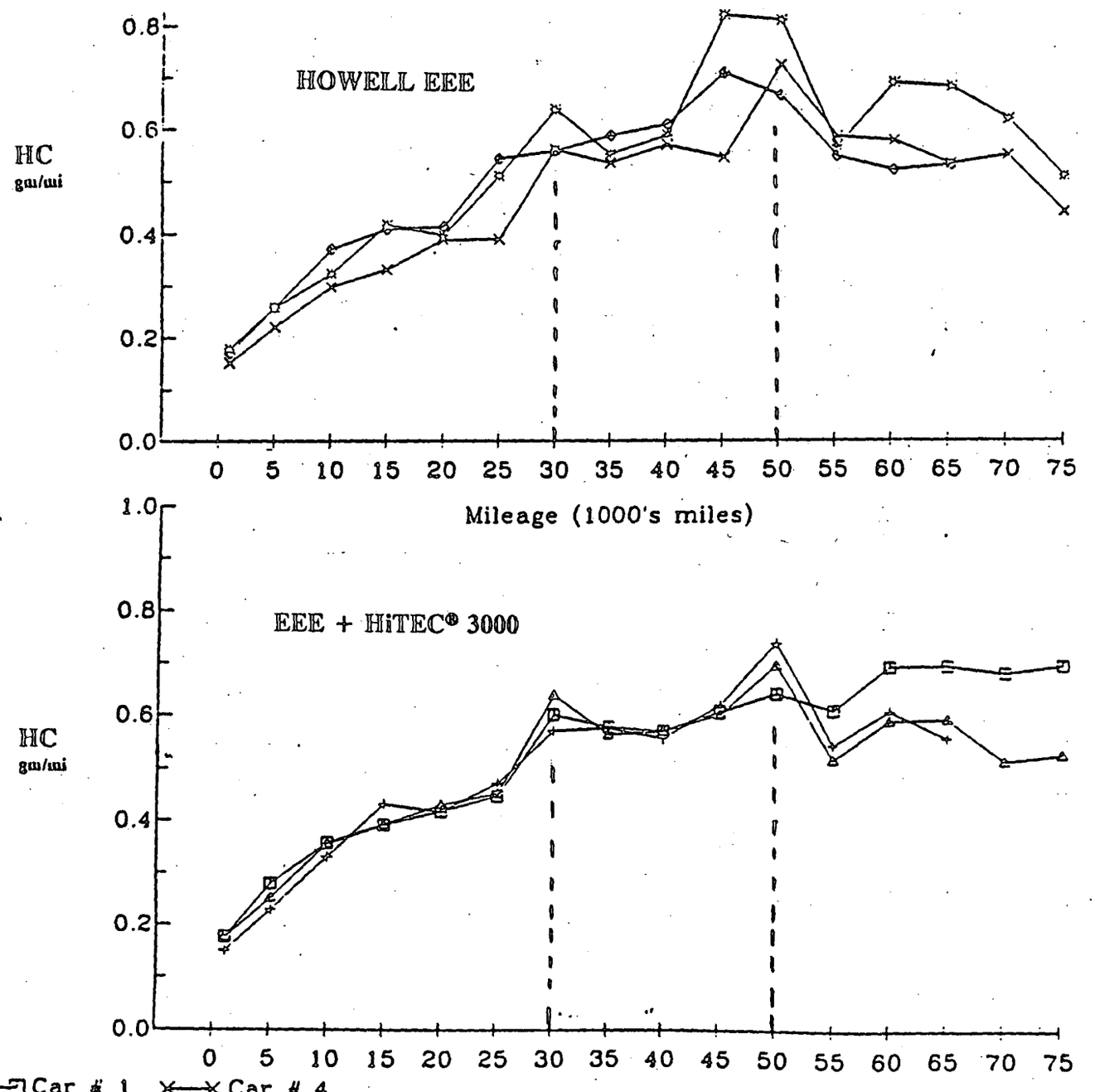
- Catalyst durability testing: 100,000 miles on GM Corsicas; 25,000 miles (at 100 MPH constant speed) on GM Corvettes; 35,000 miles at up to 80 MPH per hour on Ford Crown Victorias.

- Joint Ethyl-EPA emission correlation tests on a variety of test vehicles.

- Fuel specific tests, some involving EPA, which demonstrated no adverse differences between commercial and certification fuels blended with Additive.

- Tests with MTBE and ethanol showing both compatibility and an additional likelihood of benefits from Additive.

FORD CROWN VICTORIAS -- ETHYL TESTS



2

Particulate Emissions from Current Model Vehicles Using Gasoline with Methylcyclopentadienyl Manganese Tricarbonyl

R. H. Hammerle, T. J. Korniski, J.E. Weir,
E. Chladek, C. A. Gierczak and R. G. Hurley

Research Staff
Ford Motor Company
Dearborn, Michigan 48121

Table II.

Regulated Emissions

Vehicle Number	Odometer (miles)	Correlation Cell			
		HC g/mi	CO g/mi	NO_x g/mi	No of Tests
304 MMT	55,000	.548 ±.061	3.242 ±.206	.200 ±.009	6
305 Clear	5,000	.120 ±.008	1.840 ±.184	.118 ±.015	6
	20,000	.119 ±.003	2.228 ±.146	.141 ±.012	6
	55,000	.154 ±.004	3.596 ±.252	.131 ±.008	6
306 MMT	5,000	.142 ±.010	1.812 ±.113	.106 ±.009	6
	20,000	.172 ±.014	2.279 ±.140	.078 ±.010	6
	55,000	.173 ±.016	1.734 ±.125	.314 ±.056	6
307 Clear	55,000	.353 ±.034	4.709 ±.377	.178 ±.019	6

Note: standard deviations are shown

EXPLORERS

3

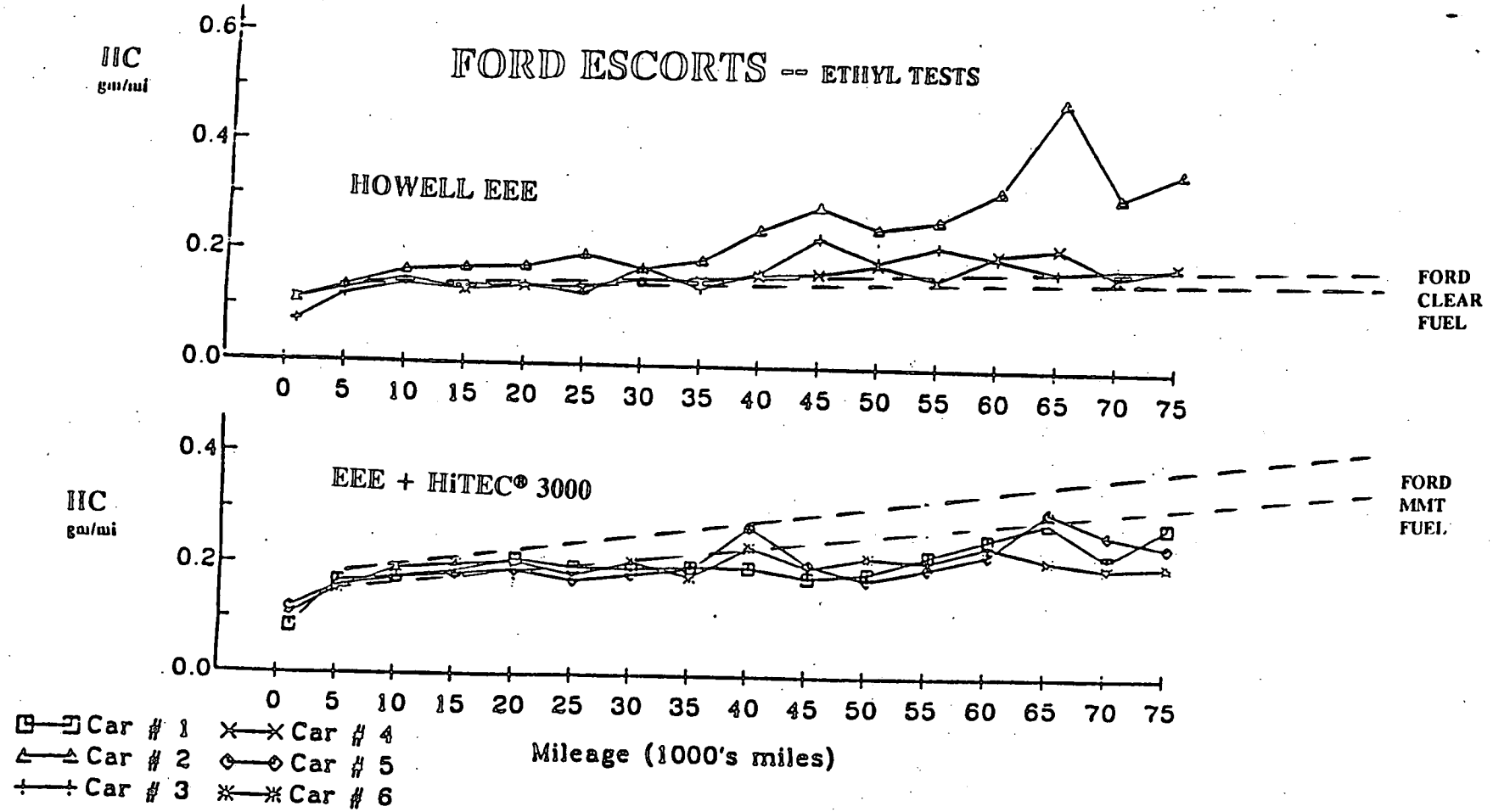
PROTOTYPE ENGINE

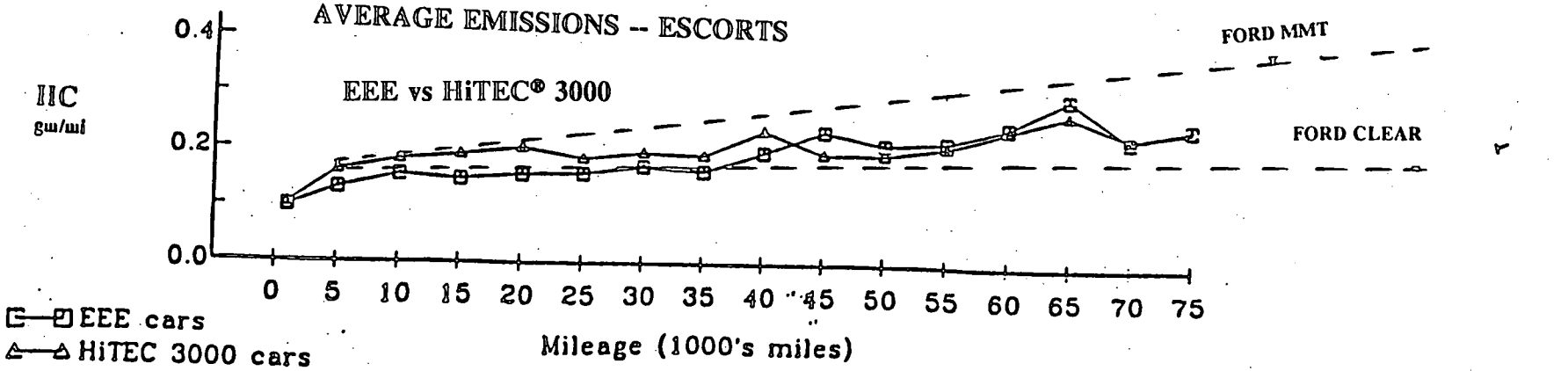
HYDROCARBONS
AT 55,000 MILES --

CLEAR FUEL CARS
305: 0.154 gm/mi
307: 0.353 gm/mi

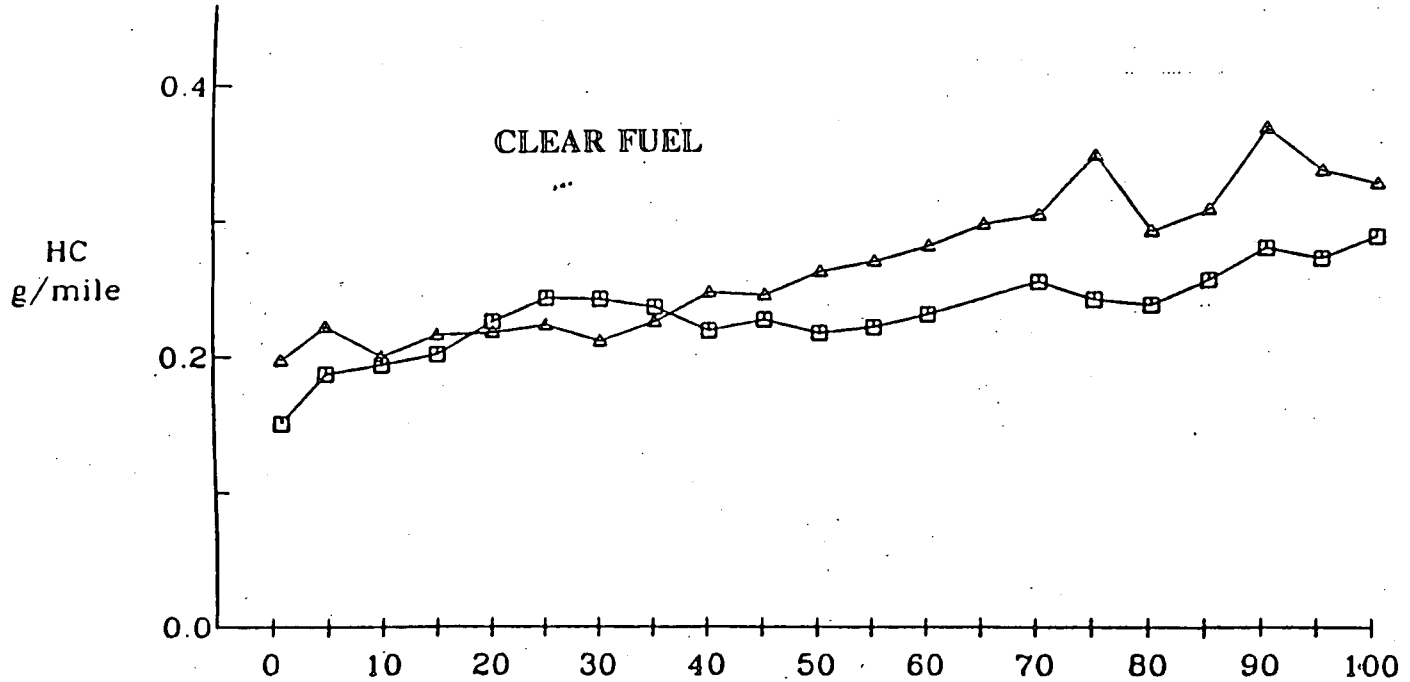
MMT FUEL CARS
304: 0.548 gm/mi
306: 0.173 gm/mi

P 20

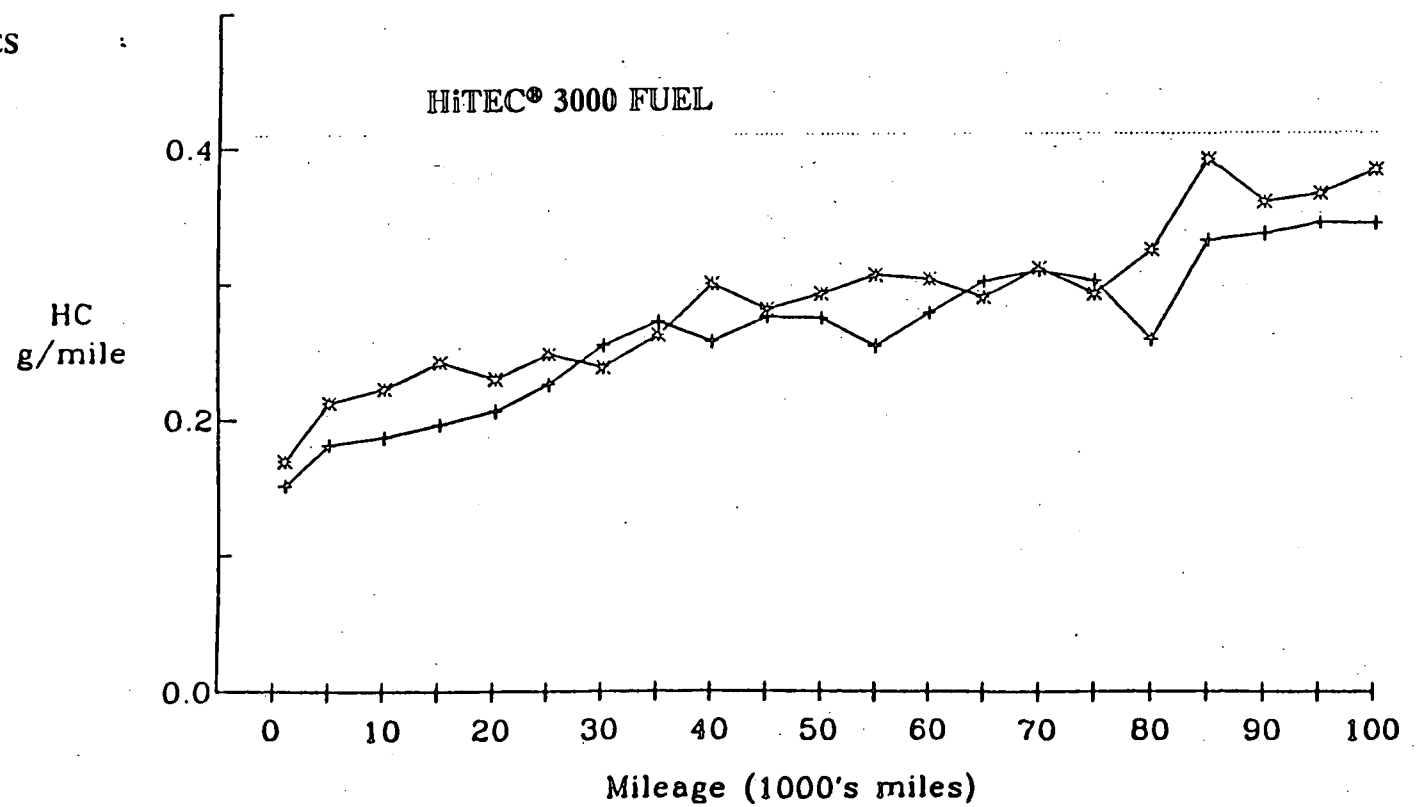

FORD ESCORTS -- ETHYL TESTS
HC
gm/mi
HOWELL EEE
FORD
CLEAR
FUEL
EEE + HiTEC® 3000
FORD
MMT
FUEL
Car # 1
Car # 2
Car # 3
Car # 4
Car # 5
Car # 6
Mileage (1000's miles)


AVERAGE EMISSIONS -- ESCORTS
HC
gm/mi
EEE vs HiTEC® 3000
FORD MMT
FORD CLEAR
EEE cars
HiTEC 3000 cars
Mileage (1000's miles)

1988
CHEVROLET
CORSICAS
ETHYL TESTS



AVERAGES
of
EMISSION
MEASUREMENTS
EVERY 5000 MILES



5

AVERAGE DIFFERENCE IN TAILPIPE POLLUTANT EMISSIONS
(HiTEC® 3000 MINUS HOWELL EEE)

R+M/2 OCTANE 92.7 | R+M/2 OCTANE 92.1